Claims

1. Method of measuring a depth of a hole in a composite-material workpiece (W) being machined by an orbital cutting process, comprising the steps of:

a) applying a low-level electric potential (U) to an electrically insulated cutting tool (14), the cutting tool having a longitudinal center axis (16) and a cutting head (57) with radial and axial cutting edges (60, 58) and with a predetermined axial length (L);

b) rotating the cutting tool (14) about the longitudinal axis (16);

c) axially advancing the cutting tool (14) towards the workpiece (W);

d) determining a first zero reference position of the cutting tool as it initially makes contact with a first outer surface (W_1) of the workpiece and thereby closing an electric circuit through a grounded workpiece (W);

e) keeping a measuring means for measuring an axial movement of the cutting tool activated from the first zero reference position;

f) performing an orbital rotation of the cutting tool (14) about a principal axis;

g) axially feeding the cutting tool into the workpiece;

h) monitoring a specific character of the electric potential during the advancement of the cutting tool through the workpiece;

i) detecting the point of breaking of the electric circuit when the cutting head (57) of the cutting tool (14) penetrates an opposite, second surface (W_2) the workpiece; and

j) determining by help of the measuring means the depth (d) of the hole by deducting the predetermined axial length (L) of the cutting head (57) having penetrated the workpiece (W) from the total length of axial advancement of the cutting tool (14) from the first zero reference position to the point of breaking of the electric circuit through the workpiece.

2. Method of measuring a depth of a hole in a composite-material workpiece (W) being machined by an orbital cutting process, comprising the steps of:

a) applying a low-level electric potential (U) to an electrically insulated cutting tool (14), the cutting tool having a longitudinal center axis (16) and a cut-

ting head (57) with radial and axial cutting edges (60, 58) and with a predetermined axial length (L);

b) rotating the cutting tool (14) about the longitudinal axis (16);

c) axially advancing the cutting tool (14) towards the workpiece (W);

d) determining a first zero reference position of the cutting tool as it initially makes contact with a first outer surface (W_1) of the workpiece (W) and thereby closing an electric circuit through a grounded workpiece;

e) keeping a measuring means for measuring an axial movement of the cutting tool activated from the first zero reference position;

f) performing an orbital rotation of the cutting tool (14) about a principal axis;

g) axially feeding the cutting tool into the workpiece;

h) monitoring a specific character of the electric potential during the advancement of the cutting tool (14) through the workpiece (W);

i) detecting the point of breaking of the electric circuit when the cutting head (57) of the cutting tool (14) penetrates an opposite, second surface (W_2) the workpiece (W);

k) performing a small incremental increase of the radial offset of the cutting tool (14);

l) axially backing the cutting tool (14) to make contact with the second surface of the workpiece for determining a second reference position of the cutting tool as it recloses the electric circuit; and

m) calculating the depth (d) of the hole produced by the cutting tool (14) by the help of the obtained two reference positions.

3. Method according to claim 1 or 2, **characterized** in that said steps are carried out in a composite-material workpiece (W) comprising at least two layers of material.

4. Method according to claim 3, **characterized** in that at least one of said layers comprises a fiber-reinforced composite material.

5. An orbital machining apparatus for producing a hole in a composite-material workpiece (W) and measuring the depth (d) of the hole being produced, comprising a rotatable spindle (13) for carrying a cutting tool (14) having a longitudinal center axis (16) and a cutting head (57) with radial and axial cutting edges (60, 58) and with a predetermined axial length (L);

a first actuator (12) configured for rotating the cutting tool (14) about its longitudinal center axis (16) during the machining of the hole;

a second actuator (20) configured for moving the cutting tool (14) in an axial feed direction towards and into the workpiece (W) substantially parallel to said tool axis (16), said second actuator (20) being simultaneously operable with said first actuator (12);

a third actuator (22) configured for rotating the cutting tool (14) about a principal axis, said principal axis being substantially parallel to said center axis (16) of the tool (14) and coaxial with a longitudinal center axis of the hole to be machined, said third actuator (22) being simultaneously operable with said first and second actuators (12, 20); and

a radial offset mechanism (24) configured for controlling the radial distance of the center axis of the cutting tool (14) from said principal axis, **characterized** in that the spindle (13) is connected to a low voltage source (U) and to a measuring means for measuring the axial movement of the spindle (13), said spindle being provided with ceramic bearings (40) electrically insulating the spindle (13) from surrounding components of the orbital machining apparatus (10), said measuring means being configured to register a first zero reference position of the cutting tool (14), when the cutting tool initially makes contact with a first surface (W_1) of the workpiece (W) and closes an electric circuit with the ground through the workpiece (W) and to register a second reference position, either when the electric circuit is broken as the cutting head (57) has penetrated an opposite, second surface (W_2) of the workpiece (W), or when the cutting head (57), after having penetrated the second surface (W_2), is backed to make contact with the second surface (W_2) of the workpiece for determining a second reference position of the cutting tool (14) as it recloses the electric circuit with ground.